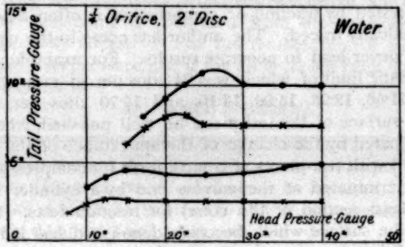
SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY 1903.

GENERAL PHYSICS.

188. *Pressure Regulator.* **W. K. Hatt.** (Frank. Inst., Journ. 154. pp. 101–106, Aug., 1902. Paper read before the Indiana Academy of Sciences, Jan. 27, 1902.)—A flat disc placed in front of a nozzle, and free to move to or from it, is held against a jet of water issuing from the nozzle by the atmospheric pressure the other side of it, just as in the well-known experiment with a ball. With a ¼-in. nozzle and a 2-in. flat disc, the pressure on the discharge side varied only from 2·5 to 2·3 lbs. per sq. in., while the supply varied in pressure from 40 lbs. to 10 lbs. per sq. in. With higher discharge pressures the regulation was not as good, and a certain minimum difference of pressure is needed for good regulation. The annexed curves show the results obtained. By giving the disc a conical surface, so as to present a constant sectional area to the expanding jet, a constant *difference* of pressure is obtained. A. E. L.



189. *The Base-Line Measurements for the 98th Meridian Triangulation.* **J. F. Hayford.** (Eng. News, 48. pp. 162–164, Sept. 4, 1902.)—This article sets forth the principal features of the work of measurement of nine primary bases which are to control the lengths on a portion of the 98th meridian triangulation; this triangulation will, when completed, stretch from the Canadian border of the United States south to the Rio Grande. A full account of these base measures will be found in Appendix No. 3 of the (United States) Coast and Geodetic Survey Report for 1901. In carrying out

the work the object aimed at was to effect the requisite accuracy at the minimum time and cost. All nine bases were measured in advance of the triangulation in part, the apparatus being standardised before and after those nine measurements—a method which is much more economical of time than the usual past practice of measuring each base as it is required, and standardising before and after each base measurement; the method also involves no loss of accuracy. The average interval between bases was made short (rather more than 100 miles), in contrast to that of 250 miles in the transcontinental triangulation, and especial attention was paid to securing good geometric conditions in the base nets, which are the weakest portion of the triangulation. The average stay at each base was less than sixteen days. Five sets of apparatus were used, four steel tapes and a bar apparatus; two of the steel tapes were 100 m. long and two 50 m.; the use of five sets gives partial elimination of their individual errors on each base. All five sets were used on each base, 1 km. of each being measured by all five; the remaining sections of each base were measured twice, and on an average one-fifth of these remaining measures were made with each apparatus. The average probable error for the nine bases is 1 part in 1,200,000, and was computed from residuals which include the effects of the errors peculiar to each apparatus, whereas the probable error usually given with a base length depends simply upon the power of the given apparatus to reproduce its own measurements. W. S.

190. *Measurement of the Elastic Limit of Metals.* **C. Fremont.** (Comptes Rendus, 135. pp. 281–283, Aug. 4, 1902.)—The measurement of the elastic limit of metals tested by traction or compression is often determined by a diagram automatically traced. The author has come to the conclusion that the method can never lead to accurate results. For example: a sample of steel, the real elastic limit of which was 24 kilos per sq. mm., gave from the diagrams 8·55, 11·56, 12·95, 13·90, 14·10, and 15·70 kilos per sq. mm. He advises that the surface of the test-piece be well polished, when the elastic limit will be indicated by the change of the appearance of the surface. He has experimented with test-pieces of conical form for compression, and in the form of cones terminated at the narrow end by a cylinder (of the same section as the least section of the cone) for traction tests. Microscopical examination of the surface which becomes depolished has led to the classification of metals into two groups. In the first type the deformation takes place suddenly under a given force, the depolished surface is clearly marked, and the elastic limit is exactly expressed by a number. Metals of the second type, on the other hand, deform gradually under a constant force, and the depolishing is not clearly limited by a line. W. W. H. G.

191. *Measurement of Compressibilities of Vapours.* **B. D. Steele.** (Chem. Soc., Journ. 81. and 82. pp. 1076–1086, Aug., 1902.)—This gives an account of a special apparatus devised to determine for certain vapours the deviations from Boyle's Law at pressures of about 40 mm. with an error not greater than 1 in 3,000. The special features are: (1) elimination of all temperature corrections; (2) measure of the pressure by setting the mercury surface to carefully sharpened glass points; (3) the volume occupied by the vapour is determined by weighing the mercury introduced into the apparatus. The temperature of the experiments was 129·6°, the boiling-point of chlorobenzene at 719 mm. pressure. Full description of the apparatus is given, and results for benzene and ether are tabulated. J. W. P.

192. *Microscopic Effects of Stress on Platinum.* **T. Andrews** and **C. R. Andrews.** (Roy. Soc., Proc. 70. pp. 250–252, July 8, 1902.)—Experiments with a polished cube of platinum, measuring 0·3 in. each way, showed that, when stressed under a compressive load of 12·82 tons per sq. in., which sufficed to reduce its height by 10 per cent., it developed fine stress-bands or slip-bands, similar to those described by Ewing and Rosenhain [see Abstract No. 1196 (1899)]. The structure of the metal, invisible prior to stressing, was thus altered and developed so that it could be viewed under the microscope, the surface examined being one of those parallel to the line of pressure. The lines of least resistance were mainly at an angle of about 45° to the pressure line, but the line of greatest weakness was not always at that angle. The chief lines of disruption corresponded in the main with the size of the primary crystal grains, the finer slip-bands with the secondary or minute grains forming the mass. W. G. M.

193. *A Method in Hygrometry.* **C. Barus.** (Science, 16. pp. 33–34, July 4, 1902.)—In his experiments on diffusion of nuclei in hydrocarbon vapours, the author noticed that on certain days the experiments were apt to break down ; at a definite pressure and after condensation had begun in the nucleated region in the column of air in the receiver, this column was liable to condense as a whole on exhaustion instead of showing a sharp plane of demarcation between the nucleated air below and the pure air above. Tests made showed that this was due to the hygrometric state of the atmosphere, and the author suggests that this might be made a method of hygrometry, by suddenly cooling by expansion artificially nucleated air until a fog just appears. The dew-point is computed from the pressure decrement on exhaustion thus determined. If t be the temperature of the air in degrees Centigrade, and p its pressure, and if the air is cooled from 20° and 76 cm., an approximate formula is—

$$dt/(t+273)=0{\cdot}29dp/p,$$

so that roughly 1 cm. of pressure decrement will correspond to a little more than 1 degree of temperature in a dew-point apparatus, and rarely will more than 10 or 15 cm. of pressure difference be required. The author gives a table of results of his tests (referred to above) on ordinary room air, on the same artificially dampened and again artificially dried. W. C. H.

194. *Ocean Currents.* **H. C. Russell.** (Roy. Soc. N. S. Wales, Journ. and Proc. 35. pp. 30–40, and pp. 336–346, 1902. Papers read before the Roy. Soc. of N. S. Wales, Nov. 7, 1900, and Nov. 6, 1901.)—The author gives the title "Current Papers," to the series of memoirs, of which these form the fifth and sixth, on ocean currents as indicated by bottles thrown overboard. The memoirs contain tables and charts. About a fifth of all the bottles are recovered, fourteen in one month has so far been the maximum. The rate of travel is difficult to ascertain, as, no doubt, many current papers are found a long time after landing, and their landing is often delayed by winds from the shore. 25·4 miles per day is the maximum speed estimated : this was in the Indian Ocean, between latitude 10 and 33 south, where all the bottles seem to travel very fast. The average rate per day between the equator and latitude 10 south is 13·3 miles. One bottle drifted for six years, being found in 1901 in Spencer Gulf, not far from the spot where it had been dropped. Two bottles reached Stewart Island, south of New Zealand, from the Falkland Islands, having apparently travelled east at the average rate of 11 miles per day. One bottle from Cape Horn landed on the Ashantee coast of West Africa, apparently after a course to the N.N.W., whilst all the other bottles from Cape Horn go eastward to Australia. The general drift is to the east. The first memoir also contains the log of the ss. *Waikato*, which broke down south of South Africa on June 5, 1899, and drifted in the Indian Ocean till September 15, 1899; the main drift was eastward, but near Africa the vessel described five or six loops. The corks of the bottles should be coated with pitch, by dipping the neck into hot pitch. H. B.

195. *Phenomena Observed in China on the Eruption in Martinique.* **de Moidrey.** (Comptes Rendus, 135. p. 322, Aug. 11, 1902.)—This is a note on the effects observed at Zi-Ka-Wei, in China, where after a long period of magnetic calm the bifilar magnetometer indicated a sharp increase of the horizontal component, and remained disturbed for about eight hours, on the 8th of May, the date of the explosion in Martinique. The large registering barometer also was much disturbed, and acted like a seismograph, showing a trembling of the ground, following the Mont Pelée eruption, which must have taken 4 hours 27 minutes to be propagated to the spot in question. The observatory of Zi-Ka-Wei is situated to an approximation within 10′ on the meridian opposite to that of Martinique. J. J. S.

196. *The Ben Nevis Observatories. Part II.* 1888–1892. **A. Buchan** and **R. T. Omond.** (Roy. Soc. Edinburgh, Trans. 42. 2. pp. 1–445.)—The preface, introduction, tables, and appendices fill the whole volume. The observations concern hourly barometer readings, dry and wet bulb temperatures, rainfall, sunshine, wind direction and force, and clouds. From July, 1890, the records of Ben Nevis and the Fort William Observatories are printed side by side. On Ben Nevis a Fortin barometer is used, further a Richard aneroid barograph, but the records of the latter are not printed. The air temperature records on the Ben Nevis depend upon personal observations, as the frozen fogs cover everything with ice crystals, and the snow depth may reach 12 ft. The louvred screens, bearing the instruments, are mounted on ladder-like stands; the choked louvres are replaced, and the bulbs kept about 4 ft. above the surface. The Campbell-Stokes sunshine recorder is the only automatic registering instrument that can be exposed on the top of the Ben Nevis Observatory. Fort William was in 1890 equipped with registering instruments; additional eye observations are taken seven times a day. The main portion of the volume is tabular, and the data are not discussed. In addition to the preface and introduction, the volume contains the Ben Nevis log-book for 1891, and in the appendix the following papers or abstracts of papers, partly reproduced from other publications: Diurnal Range of Barometer in Fine and Cloudy Weather, by A. Buchan and R. T. Omond; Ben Nevis Meteorology in Clear and Foggy Weather, by J. Y. Buchanan; Report on Atmospheric Dust, by J. Aitken; Influence of High Wind on Barometer and Relations of Pressure and Temperature at the Ben Nevis Observatories, by A. Buchan; Winds of Ben Nevis, by R. T. Omond and A. Rankin; Change of Temperature with Height during Anti-Cyclones, by R. T. Omond; Differences between the Barometers of Ben Nevis and Fort William, by R. T. Omond; Hourly Readings of a Black Bulb in Vacuo, by R. T. Omond; Gales on Ben Nevis, by A. Rankin; Silver Thaw on Ben Nevis; Diurnal Temperature Range at Summit and Base of Ben Nevis, Lady Franklin Bay, and Hong Kong; Frost in Scotland, 1895; Wragge's Ben Nevis Observations of 1882—these four papers by R. C. Mossman; Comparisons of Observations and Temperature Corrections of Barometers, by R. T. Omond ; Adjustment of Mean Hourly Values for Diurnal Range, and Ben Nevis Barometer Reductions to Sea-Level. H. B.

197. *Rain and Moon Declination.* **H. C. Russell.** (Roy. Soc., N. S. Wales, Journ. and Proc. 35. pp. 113–115, 1902.)—Taking into consideration only the rain records from the inland stations of New South Wales, and disregarding the irregular records from the coast regions, which receive much more rain, the author finds evidence of a period of nineteen years. He plots the extreme southern distance of the moon from the equator for each year, and points out that there is abundance of rain for the six years during which the moon moves towards the south, followed by a period of drought, when the moon is turning to the north ; the latter period lasts about twelve years. Some of the rain records go back to 1848. H. B.

198. *Solar and Meteorological Variations of Short Periods.* **N. Lockyer** and **W. Lockyer.** (Comptes Rendus, 135. pp. 361–364, Aug. 25, 1902.)—In India low pressures prevail in summer (April to September) and high pressures in winter. The latter attain maxima every three and a half years, and those maxima are followed by less pronounced minima. This holds for India in general and for separate stations (Calcutta, Bombay, Madras, &c.). Cordova gives inverse curves, and similar periodicities have been observed in England and elsewhere. An analogous period of three and a half years is presented by the subsidiary maxima and minima of solar protuberances and by the variations in the solar latitudes affected by spots. The eleven and thirty-five years periods also influence the meteorological conditions. H. B.

199. *Solar Protuberances and Terrestrial Magnetism.* **N. Lockyer.** (Comptes Rendus, 135. pp. 364–365, Aug. 25, 1902.)—From an examination of the solar observations, conducted in Rome since 1871, the author concludes that the epochs of great magnetic storms of Ellis are identical with the greatest chromospheric activity near the poles of the sun ; and that the curves of terrestrial magnetic activity and of protuberances observed near the solar equator are on the whole in agreement. H. B.

REFERENCE.

200. *Recent Progress in Astronomy.* **J. K. Rees.** (Science, 16. pp. 366–372, Sept. 5, 1902. Commencement address delivered at the Worcester Polytechnic Institute, June 12, 1902.)

LIGHT.

201. *Measuring Objects in the Microscope.* **F. E. Ives.** (Frank. Inst., Journ. 154. pp. 73–76, July, 1902.)—The image of an illuminated scale is projected in the plane of the object by means of the substage condenser. In the author's arrangement a Welsbach light, with ground-glass chimney and hood, illuminates a jeweller's saw set up, on a block of wood, at a suitable distance from the condenser. The distance between two teeth was equivalent to $\frac{1}{50}$ mm. on the stage micrometer. G. E. A.

202. *Testing Microscope Objectives.* **C. V. Drysdale.** (British Optical Journ. 1. pp. 270–273, July, 1902.)—A small cap, containing a small piece of plane, parallel, unsilvered glass set at 45°, is placed over the eyepiece, the glass being illuminated by light from a distant source. On the stage of the instrument is placed an Abbe silvered test-plate, provided with cover-glasses of known thickness. The test-plate reflects back to the eye the rays which pass down the microscope and the appearances seen, according as the objective is correct or otherwise, are described. G. E. A.

203. *Illumination of Cross Wires in a Collimator.* **C. A. de Campos-Rodrigues.** (Zeitschr. Instrumentenk. 22. pp. 142–143, May, 1902.)—A satisfactory means of illuminating the cross wires of the collimator of an astronomical telescope is obtained by attaching to the eyepiece cover a plate having in the centre a small opaque disc somewhat greater than the image of the objective as seen at a little distance from the eyepiece. The opaque surface causes the cross wires to be illuminated from the sides only, and to appear bright on a dark ground. G. E. A.

204. *The Great Refractor at the Royal Astrophysical Observatory, Potsdam.* **H. C. Vogel.** (Zeitschr. Instrumentenk. 22. pp. 169–177, June, 1902.)—This has two objectives with apertures 80 cm. and 50 cm. respectively, the focal length of each being 12 m. The former lens is achromatised for chemical rays and gives good coincidence from 470 $\mu\mu$ to 380 $\mu\mu$; the latter lens is achromatised for visible rays. The mechanical part of the installation was carried out by Messrs. Repsold; Messrs. Schott, of Jena, supplied the material for the objectives, which were ground by Messrs. Steinheil. Details with regard to the supports and other parts of the instrument are given along with a woodcut of the complicated mechanism round the eyepiece, and a photo of the complete instrument and its housing. The movable part of the instrument weighs 7,000 kg., and the observers are accommodated on a large movable platform. The dome is 21 m. wide and 18 high, and rests on a circular wall 5½ m. high. The cost of the telescope, including carriage and setting up, was about £11,700. The dome can be moved by hand or by electricity. G. E. A.

205. *Atmospheric Irregularities; and Zonal Aberration of Objectives.* **K. Strehl.** (Zeitschr. Instrumentenk. 22. pp. 213–217, July, 1902.)—The paper treats of the effect on telescopic definition, first of scintillation, second of zonal aberration of the objective. Exner's explanation of scintillation is adopted [see Abstract No. 2077 (1901)], which supposes the wave-fronts from the stars to acquire irregular convexities and concavities in passing through our atmosphere, owing to constantly shifting irregularities in the air. But the question is here discussed as a diffraction phenomenon, not as one in geometrical optics. The author calculates the amplitude of vibration of a star-image under certain conditions, and the effect on definition. The ill effect is found to increase rapidly with size of objective, till it attains a nearly constant limit for large objectives. This contradicts the common statement that the blurring is proportional to the cube of the aperture. In the second part of the paper, the theoretical loss of definition due to spherical form is shown to be insignificant. The loss is stated to be mainly due to mechanical zonal aberration, and chromatic difference of focus. Change of index with zone may also be a factor. The great trouble is, not in the form being spherical, but in the mechanical difficulty of making it truly spherical.

A. E.

206. *Reflection and Refraction by a Transparent Body having Rapid Translation.* **J. Boussinesq.** (Comptes Rendus, 135. pp. 220–225, July 28, 1902.)—A simple hypothesis regarding the motion of such a body through the ether is to suppose the ether a fluid of extreme tenuity and the body to have large meshes, and to move through the ether displacing it very slightly. If at the same time the ether performs luminous vibrations, the simplest supposition that can be made about the actions exerted on an ether particle by the ponderable matter meeting it is to regard those actions as composed of two parts, the first a *mean* part of sensibly the same magnitude during a large number of successive vibrations, and producing the small translational motion of the particle, the second a part alternately positive and negative, constituting the resistance offered by the ponderable matter to the vibratory motion of the ether particle. On those assumptions the author deduces the equations of vibrational motion of the ether permeating a homogeneous substance of index of refraction μ, and shows that they lead to Fresnel's conclusion that the motion of a medium has the same effect on the velocity of light as though it communicated to the ether the fraction $1 - 1/\mu^2$ of its velocity of translation. The next establishes equations giving the boundary conditions at the surface of separation of two media. Finally he shows how to deduce the *aberration* of a ray in a single moving medium, that is, the angle between the ray and the wave normal. W. S.

207. *Refractive Indices of Fluorite, Quartz, and Calcite.* **J. W. Gifford.** (Roy. Soc., Proc. 70. pp. 329–340, July 29, 1902.)—The method employed was to measure the deviation produced by each of the angles of an equilateral prism of the substance, the mean reading being then taken as the deviation for an angle of 60° exactly. A Hilger spectrometer gave readings to ¼″, and observations were made at 15° C. It was found that μ was practically the same for R.H. and L.H. quartz. Tables are given of the refractive indices of the above substances between the wave-lengths (Rowland's values) 7950 Rb and 1852·2 Al; *e.g.*, for 5893·17 Na (D) the values are: For fluorite, 1·4345651; for R. quartz ordinary, 1·5441558; for R. quartz extraordinary, 1·5533662; for calcite ordinary, 1·6583551; and for calcite extraordinary, 1·4863915.

G. E. A.

208. *Anomalous Dispersion in Neodymium and Praseodymium.* **H. Dufet.** (Journ. de Physique, 1. pp. 418–426, July, 1902. Paper read before the Société

Française de Physique, March 7, 1902.)—Crystals of the sulphates of the above elements present the phenomenon of "anomalous dispersion of the optic axes." Tables are given of the refractive indices of these crystals and details of their spectra. The angle between the optic axes, which is about 90°, is then measured by means of the rings. In observing the axes in the light of the spectrum, the angle in the neodymium crystal is seen to increase somewhat rapidly as the absorption band between $\lambda = 0{\cdot}595\ \mu$ and $\lambda = 0{\cdot}571\ \mu$ is approached, and reaches a minimum after this band. It afterwards increases very slowly up to the value for thallium light. This is very near an absorption band in the green. Curves are given, showing the variation of the axial angle with $1/\lambda^2$. Sulphate of praseodymium shows similar but more marked properties, since the optic axes may be traced through the absorption band.
G. E. A.

209. *Study of "Flicker."* **T. C. Porter.** (Roy. Soc., Proc. 70. pp. 313–329, July 29, 1902.)—This paper continues the work referred to in Abstract No. 1318 (1898). The curves connecting the rate of rotation of the disc, and the colour, rate of rotation and width of the coloured sector for the flicker just to vanish, are here given, with additions and corrections. The various points of improvement are enumerated, and the following matters were investigated :—(1) The connection between the number of revolutions of a disc half white, half black, at which flicker just vanishes, when the rotating disc is differently illuminated ; (2) the connection between the rate of rotation and the magnitude of the white sector ; the illumination of the disc from external sources is maintained constant. Empirical formulæ, curves and tables of figures are given.
J. W. P.

210. *Stereoscopy.* **E. Colardeau.** (Journ. de Physique, 1. pp. 427–440, July, 1902. Paper read before the Société Française de Physique, March 7, 1902.)—The author discusses the failures of stereoscopic photography at short distances, and describes apparatus for obtaining correct results. When unequal similar objects are so placed as to subtend equal angles, the ordinary camera represents them as of equal size : the draughtsman who measures with his pencil at arm's length does the same ; the draughtsman who trusts to his eye alone draws the actually larger objects as of larger size ; the stereoscopic camera shows the larger and more remote object as apparently larger, though either half of the stereoscopic slide has all the images identical in size. Stereoscopically viewing the picture also apparently rectifies the exaggerated perspective of wide angle lenses. When a photograph is taken looking upwards, the parallel vertical lines of a building seem to converge towards the top, and the building seems to lean backwards, when the swing-back has not been used ; on our looking upwards at the same building there is no suggestion that the building is leaning backwards ; if we take a stereoscopic slide, made without swing-back, and lift the stereoscope so that we look upwards at the proper angle, the effect is exactly the same as that of looking upwards at the building itself. At a smaller or greater angle the building seems to lean back or to overhang.
A. D.

211. *Some Explanation of the Properties of Pleochroitic Crystals.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 48–91, 1902. Also Phil. Mag. 4. pp. 90–97, July, 1902.)—In a former paper (1884, same journal) the author deduced, from general theory, the explanation of the appearances shown by plates of pleochroitic crystals cut normal to an optic axis and placed in convergent light, and later gave it a more general application. The general developments of the latter being confined to certain regions of the crystal, the present extensive mathematical work developes and discusses formulæ which include the whole region of the optic axes of symmetrical crystals. It results that there are two elliptically polarised waves propagated in every direction through a pleochroitic crystal, the position of the vibration ellipses being crossed. The rings to be seen by using polariser or analyser alone is a direct proof of the existence of the two elliptic waves rotating in the same direction demanded by the theory, and the general law is expressed that these idiophanic rings are most distinct when the plane of incident polarisation is parallel to one of the two directions of polarisation in the polarisation axis. They then appear in the absorption bands but are absent in the corresponding normal direction. A new effect is obtained by passing blue light through a Nicol, a ¼-wave plate, and a plate of Andalusite to a telescope. Rotation of the ¼-wave plate causes a dark vertical strip to break up into two dark spots which rotate round the polarisation axis twice as fast as the ¼-wave plate and in the same direction as the latter. This new phenomenon further strengthens the author's theory. G. E. A.

212. *Retinal Phenomena.* **A. Charpentier.** (Comptes Rendus, 135. pp. 56–58, July 7, 1902.)—The author showed in the Comptes Rendus for 1891 and 1896 that every luminous excitation determines in the retina a double oscillatory process which travels along the retina. A kind of black band is thus produced which may interfere with another stimulus applied at the right instant at another point of the retina. It is found that the oscillations have a frequency of 33 periods per second and travel at 71 m. per second. [See also Abstract No. 1280 (1901).] A. D.

213. *Photochemical Solarisation a Phenomenon of Development.* **J. Precht.** (Phys. Zeitschr. 3. pp. 426–428, July 1, 1902.)—Reversal of over-exposed portions of a negative can be completely obviated. To the developer used, say a 4 per cent. edinol solution, add 1 per cent. of Bayer's acetone sulphite; the time of first appearance is increased about eightfold; stop the development in three minutes. The result is a thin negative, true in gradation, which can be intensified to printing density. Reversal does not begin to make its appearance until in the course of the fourth minute; then the less exposed portions begin to gain so rapidly on the over-exposed portions that they acquire greater density than these do. In ordinary development the same thing occurs, but much more promptly. With an ordinary developer solarisation begins after exposures of from $32 \cdot 10^4$ to $106 \cdot 10^4$ Hefner-metre-seconds, according to the plate. The addition of acetone sulphite, with short development, obviates reversal at any rate up to nine times this limit. The effect seems to be due to the removal by the acetone sulphite of the oxidation products of the developer; in protracted development the reduced permeability of the over-exposed parts of the gelatine locally retards the action of the developer. Reversal takes place at points which have visibly been impressed with a faint image. The sensitive plate, developed as above, will show differences in the actinic effect even within the region of complete solarisation, so that the effect of light does not rise to a maximum and then fall off. Intermittent illumination will, under ordinary development, bring out fluctuations in the reversal effect; steady illumination to the same aggregate amount brings out a single solarised zone; development as above brings out in both cases no

reversal (mg. ribbon 3 × 16 cm. and 24 × 2 cm. at 14 cm. distance); but direct illumination at different distances for the same time brought out fluctations in the reversals which this mode of development did not do away with.
A. D.

214. *Sensitometry of Photographic Plates, III.* **J. M. Eder.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 1103–1124, 1901. From the photo-chemical laboratory of the K.K. Graphischen Lehr-und Versuchsanstalt at Vienna.) —The author has proposed, as a measure of the colour-sensitiveness of orthochromatic plates, the ratio of their sensitiveness to the blue region and to the red-green region of the spectrum, and the paper contains a description of experiments and measurements of the sensitiveness of different plates to different lights through various filters. The filters recommended are solutions of cupric-ammonium oxide, and potassium chromate, and curves are given of their absorption spectra. The ratio of the sensitiveness to blue to that to yellow varies, with amyl-acetate light from 1 : 4·7 for the best erythrosin plates to 1 : 0·08 for bad quality eosin plates. With arc-light the ratio is about three times larger. The author compares the total sensitiveness of orthochromatic and ordinary plates to amyl-acetate light and arc-light, and gives determinations of the point of maximum sensitiveness for orthochromatic, ordinary bromide, chloride and iodide plates to different lights. Comparisons are also given between measurements made by a grating and by a glass-prism spectrograph. [See also Abstract No. 1874 (1901).]
G. H. B.

215. *Minimum Deviation in Birefringent Prisms.* **C. Viola.** (Accad. Lincei, Atti, 11. pp. 24–32, July 6, 1902.)—For flat waves parallel to the edge of the prism and for equal angles of incidence and emergence, minimum deviation takes place when the external bisectrix of the prism falls in one of the planes of optical symmetry of the crystal; as also when the internal bisectrix of the prism is the direction of polarisation of the luminous wave parallel to this bisectrix. [See also Abstract No. 1634 (1900).]
A. D.

216. *Zeeman Effect.* **C. Runge.** (Phys. Zeitschr. 3. pp. 441–442, July 1, 1902. Paper read before the Physik. Gesell. d. Univ. Göttingen.) The author describes experiments made in conjunction with Paschen upon the relation between the dispersion of the spectral lines in a magnetic field and their arrangement in series. The series lines do not in general assume the simple form of normal triplets, but have a greater number of components. Lines belonging to the same series are similarly dispersed, so that on the scale of the vibration-differences they give the same diagram, equal numbers of components, and at the same distance apart. This is exactly true for Hg: two triplet series, or six series in all. The first triplet series, in Hg, consists of compound triplets, the principal lines in which are accompanied by satellites. The six series show six different types, one to each; and in addition we have the types of the satellite lines, which differ from one another. Series corresponding to one another in different elements show the same type; the components, to a scale of the number of vibrations per cm.-path, give in equal fields the same diagram as regards the number of the components and their distances apart. This is true in the second triplet series of Mg, Sr, Zn, Cd, Hg. Doublet series, in Cu, Ag, Al, Tl, and the two Na D lines, showed the same identity of diagrams and identity of types as between these different elements. The types of the two D lines are quite

different from one another, and double lines of some other elements show these two types in a reversed order. The calcium lines H and K correspond exactly to sodium D_1 and D_2. In reverse order so do calcium lines 3737·1 and 3706·2. The three types of the triplet series show lines at distances from the mid-point, on a diagram to scale of vibration frequencies, respectively (*a*) $-4u, -3u, -2u, -u, 0, u, 2u, 3u, 4u$; (*b*) $-4u, -3u, -u, u, 3u, 4u$; (*c*) $-4u, 0, 4u$. The two types of the doublet series similarly show (*a*, sodium D_2) six lines at $-5v, -3v, -v, v, 3v, 5v$; and (*b*, sodium D_1) four lines at $-4v, -2v, 2v, 4v$. And further, $3v \doteq 2u$. [See also Abstracts Nos. 1683 and 1841 (1902).] A. D.

217. *Luminosity of Rarefied Gases in a Magnetic Field.* **J. Borgmann.** (Phys. Zeitschr. 3. pp. 433–440, July 1, 1902.)—The author considers the phenomena of the action of a magnetic field upon the luminosity of rarefied gases round a wire which is connected, with the interposition of a condenser, to one pole of a Ruhmkorff's coil, of which the other pole is put to earth. Numerous variations of the experiment and of results are described, and are well illustrated by reproduced photographs. [See also Abstracts Nos. 517 (1901) and 726 (1902)]. A. D.

218. *Magnetic Birefringence in Liquids.* **Q. Majorana.** (Accad. Lincei, Atti, 11. pp. 531–539, June 15, 1902; and Comptes Rendus, 135. pp. 235–237, July 28, 1902.)—Experimental details are given [see also Abstract No. 1844 (1902)]. If the sample of dialysed iron have a positive magnetic birefringence at low values of the field and negative at higher, and if its point of inversion be very low, the negative birefringence is sensibly proportional to the square of the strength of the field. The magnetic birefringence is proportional to the thickness of the liquid, normal to the lines of force; it is also directly proportional to the concentration, and it is inversely proportional to the square of the wave-length. The liquids used behave in the magnetic field exactly as uniaxial dichroic crystals do towards the spectrum; the absorptions vary in the same way. Both in positively and negatively birefringent specimens, in normal propagation the slower wave is the more absorbed. If the plane of polarisation of rays be parallel to the field, those rays which are propagated parallel to the lines of force are absorbed equally with those propagated normally to the lines of force. A. D.

219. *Theory of the Ocular Spectroscope.* **F. L. O. Wadsworth.** (Astrophys. Journ. 16. pp. 1–11, July, 1902.)—This type of astronomical spectroscope, in which the dispersing train is placed directly in the path of the cone of rays from the telescope objective, either just inside or just outside the focus, is inferior to the two other types of instrument, the objective prism and the compound slit spectroscope, and the causes of this inferiority are discussed in the paper. The aberration introduced is dealt with, for the amount of aberration necessarily sets a limit to the resolving power of the system. In the case of a single prism of minimum deviation, the simplest case, it is shown that $\omega = 3\theta^2(\mu^2-1)\sin\phi/\mu^2\cos\phi\cos^2\phi'$, where ω is the angular width of the resulting image of an infinitely thin slit, θ the angular semi-aperture of the cone of rays, μ the index of refraction, and ϕ and ϕ' the angles of incidence of the axial pencil on the first and second prism faces respectively. From this it follows that in a continuous spectrum absorption lines whose angular width are less than ω will be obliterated. In the case of a 60° prism for which $\mu = 1·6$, $\omega = 3·25\theta^2$. In an objective spectroscope unaffected by aberration the purity of the spectrum is equal to the theoretical resolving power, and therefore if we assume a single prism of 60° and 1 in. clear aperture, set at minimum deviation, for which $\mu = 1{\cdot}6$, it can be shown that $\Omega = 0{\cdot}000019$ when the width of the line is 0·1 A.U., and $\Omega = 0{\cdot}000021$ when the width of the line is 1·0 A.U. Now in the ocular spectroscope ω must not be greater than $\frac{1}{2}\,\Omega$ if the effect of aberration is not to seriously affect the resolving power. Hence it follows that $\theta^2 > 0{\cdot}0000031$ and $\theta = 0{\cdot}00176$. In all astronomical telescopes the angular aperture is very much greater than this, and therefore the use of the prism in the direct cone of rays is inadmissible. Conversely it may be shown that if, as is usual in telescopes, $\theta = 0{\cdot}03$ about, then for the 60° prism the aperture must be less than 0·1 mm. In the case of a direct-vision prism in place of the simple prism, the aberration may be considerably reduced. For example, with a direct-vision train for which the aberration for the C line is zero and which has a dispersion of 2° between C and E, it may be shown that the limiting linear aperture is approximately 4 mm., which permits a bare resolution of the D lines, while $\omega = 0{\cdot}085\theta^2$. The following conclusions may be drawn: (1) The use of simple prisms of any angle directly in the cone of rays from the objective is only possible when the aperture is so small as to preclude any reasonable work. (2) Direct-vision prisms are better than simple prisms, but the advantage is not large and is confined to a small range of spectrum, and is further secured only at a great sacrifice of light efficiency. (3) The aberration can be reduced by placing the prism outside the eyepiece; this, however, again causes greater loss of resolving power and, worse still, prevents the use of the system in focal plane work. E. C. C. B.

220. *New Type of Focal Plane Spectroscope.* **F. L. O. Wadsworth.** (Astrophys. Journ. 16. pp. 12–26, July, 1902.)—The aberration produced by the so-called ocular spectroscope has already been shown to be so considerable as to practically render the instrument useless [see preceding Abstract], and this aberration is due to the angular aperture of the cone of rays from the telescope objective. As was shown before, $\omega = 3\theta^2(\mu^2 - 1)\sin\phi/\mu^2\cos\phi\cos^2\phi'$, and evidently the only quantities which can be varied to any degree are θ, ϕ, and ϕ'. Now a most decided improvement can be effected by decreasing θ, but this is impossible in large telescopes; but the same results may be produced by inserting in front of the prisms a negative collimator lens, for in this way θ may be made as small as one pleases and reduced to zero over a considerable range of wave-length. It will then only be necessary to insert a positive lens behind the prisms to form the image. The form and construction of these lenses will be determined by the angular aperture and the colour curve of the telescope objective. Simple lenses are preferable if no great spherical or chromatic aberration be introduced by their use. The conditions to minimise the former are first dealt with. It is shown that the longitudinal aberration, if $\mu = 1{\cdot}6$, is (1) $\delta r = 0{\cdot}21\,a^2/f$, where a is the aperture and f the focal length. Assuming as before that in order to avoid injuring the definition the effect of the longitudinal aberration must not exceed one-half the resolving power of the aperture, then $\delta r\theta/f = \lambda/b$, or (2) $\delta v = \lambda/\theta^2 = 4\lambda f^2/a^2$, and thus it follows that $\theta = \sqrt[4]{\lambda/0{\cdot}83f}$. Assuming as before that $\theta = 0{\cdot}03$, we have for f, (3) $f_{max} = \lambda/0{\cdot}67 \times 10^8 = 83{\cdot}6$ cm., when $\lambda = 5{,}600$ A.U.; or 64·2 cm., when $\lambda = 4{,}300$ A.U. This determines the linear aperture a, and hence the resolving power of the prism train. Since $a = 2f\theta$ (from (2)), therefore, (4) $a = 5{\cdot}02$ cm. or 3·85 cm. when $\lambda = 5{,}600$ or 4,300 A.U. respectively. With increase in θ the possible maximum values of f and a rapidly decrease; *e.g.*, if $\theta = 0{\cdot}1$, as it often does in photographic and in reflecting telescopes, then (5) for a single lens $f_{max}=0{\cdot}8$ cm., $a_{max}=1{\cdot}6$ mm. for $\lambda=5{,}600$; and $f_{max}=0{\cdot}6$ cm., $a_{max}=1{\cdot}2$ mm. for $\lambda=4{,}300$, which are too small. But if certain conditions be imposed on the second lens behind the prism train, the aberration may be considerably reduced and therefore the possible aperture increased. For example, if the second lens be made of the same glass and with the same focal length as the first, the aberration would be zero if the lenses were in contact, and is very small under ordinary working conditions. In this case lenses may be employed up to 5 cm. or more in diameter even when the angular aperture of the objective is as large as 1 to 5, provided it has no great chromatic aberration. When the telescope object-glass does possess chromatic aberration, it is necessary that the negative collimating lens should correct this, and therefore it may be made a combination of crown and flint glass. For the usual soft crown and dense flint glasses the equations are deduced—

$$\frac{1}{f_1}=\frac{1}{F}\left(87{\cdot}87\frac{\Delta F}{F}+2{\cdot}753+\right)$$

and—

$$-\frac{1}{f_2}=\frac{1}{F}\left(87{\cdot}87\frac{\Delta F}{F}+1{\cdot}753+\right)$$

where ΔF is the distance between the foci of the object-glass for the two rays. From (6) and (2) the values of f can be easily found when ΔF is known from the colour curve. Similarly also equations are given for the best radii of curvature. When such a compound lens is used the positive lens may be made of any material and with any focal length. The author gives diagrams and full description of instruments made on these lines for many of the large American telescopes, and finds on experiment that the best possible results are obtained. The instruments are particularly well adapted for astronomical investigations which require a large objective on account of the advantage they possess over the compound slit spectroscope because of its nature, and over the objective spectroscope because of its cost. For example: (1) The photographic survey of the spectral type of very faint stars. (2) Photographic study of the ultra-violet region of the spectra of faint individual stars. It may here be noticed that quartz lenses and prisms may be used, and if necessary the former may be corrected by fluorite. (3) Photometric studies of the relative spectral intensities of faint stars and variables. E. C. C. B.

221. *Spectra of Kathodo-Luminescent Metallic Vapours.* **P. Lewis.** (Astrophys. Journ. 16. pp. 31–35, July, 1902.)—Experiments were made on the luminescence of the vapours of the more volatile metals when excited by kathode rays. The vacuum tube consisted of a glass tube about 25 cm. long sealed at one end, the open end of which was pushed into a wider tube and cemented with wax. Immediately opposite the open end of the inner tube and a very short distance away was a plane kathode, while the anode was sealed in a side tube. The metals were placed at the end of the smaller tube and the apparatus was exhausted as far as was necessary to allow the rays to pass to the end of the smaller tube. The metal was then heated with a Bunsen burner, and the spectrum of the vapour under the influence of the kathode streams was examined. The metals experimented with were sodium, potassium, magnesium, mercury, zinc, cadmium, and thallium, also bismuth, lead, antimony, tin, and aluminium. The last five gave no appreciable luminescence, neither did sulphur, selenium, and tellurium. The first seven gave very distinct spectra whose lines were the same as are to be seen in their flame and weak spark spectra. E. C. C. B.

222. *Comparison of the Radiations from Radio-active Substances.* **E. Rutherford** and **Miss H. T. Brooks.** (Phil. Mag. 4. pp. 1–23, July, 1902.)—A careful account is given of the various actions exerted by radio-active substances. The following are amongst the phenomena considered: (1) Action of a magnetic field on uranium rays; (2) absorption of the rays by solids and gases; (3) absorption of radiation by metals; (4) absorption of the radiation in air; (5) emanating power of thorium and radium; (6) connection between the emanation and excited radio-activity; (7) the excited radio-activity due to radium and thorium compounds; (8) the decay of excited radio-activity. From the differences observed in the behaviour of the radio-active substances most closely studied—uranium, thorium, and radium—it appears that radio-activity is a very complicated phenomenon. The three substances mentioned emit negatively charged particles with high velocities similar in all respects to kathode rays. They also emit rays non-deviable by a magnetic field, which are readily absorbed by gases and thin layers of metal. These non-deflectible rays differ from one another in penetrating power and cannot consequently be ascribed to any radio-active impurity common to all the substances. In addition, thorium and radium possess the remarkable property of continuously emitting radio-active emanations which behave in all respects like radio-active gases. The emanations from thorium and radium differ greatly in their rates of decay of radiating power. The presence of an emanation gives rise to the complicated phenomenon of excited radio-activity. The non-deviable excited radiations due to thorium and radium, although apparently of the same penetrating power, decay at very different rates. Excited radio-activity is not confined to radium and thorium, for Elster and Geitel have recently shown [see Abstract No. 1918 (1901)] that a negatively charged wire, exposed in the open air, free from all possible contamination by radio-active substances in the laboratory, becomes strongly radioactive. This excited radio-activity decays at a different rate from that due to the emanations of thorium and radium, and also is of greater penetrating power. J. J. S.

223. *Chemical Action of Kathode Rays.* **G. C. Schmidt.** (Phys. Zeitschr. 3. pp. 474–475, July 15, 1902.)—The author has already shown in various ways that Goldstein's view of the reducing action of kathode rays is untenable [see Abstract No. 461 (1902)], and he now gives an additional proof. Certain aniline dye stuffs (rhodamine, cyanine, Hoffmann's violet, fluoresceine) were dissolved in gelatine and dried in a desiccator; the dried material was found to fluoresce under the influence of ultra-violet light, but not when exposed to kathode rays. D. H. J.

REFERENCES.

224. *Optical Measurements of Thickness.* **J. M. de Lépinay** and **H. Buisson.** (Comptes Rendus, 135. pp. 283–286, Aug. 4, 1902.)—The method of carrying out the principle given in a former paper [see Abstract No. 1856 (1902)] is shortly described, and results are given of the measurement of the thickness and refractive index of a plate of quartz, cut parallel to the axis, for the ordinary ray. The method is considered accurate to 0·02 – 0·01μ for the thickness, and to the sixth decimal place for the refractive index. G. E. A.

225. *Silvering Glass for Daguerreotypy.* **Izarn.** (Comptes Rendus, 135, pp. 240–242, July 28, 1902.)—Particular directions are given for producing a hard, lustrous, and tenacious coating of silver on glass by means of formol. A. D.

HEAT.

226. *Liquid Air Plant.* **F. Allen** and **W. Ambler.** (Phys. Rev. 15. pp. 181–187, Sept., 1902.)—This gives an account of a test of a liquid air apparatus in use at Cornell University. The compressor is of the four-stage type with air cylinders of 7¼ in., 3⅞ in., 2 in., and 1 in. diameter, and of 8-in. stroke. The stages of compression are 43, 170, 725, 2,600 lbs. per sq. in.; and in the liquefier (Hampson type) the pressure is about 180 atmospheres. The motor which drives the compressor is a 30-h.p. 500-volt machine running at 1,730 r.p.m. Within ten minutes from starting, the liquid air begins to flow. The results of a test were as follows: amount of liquid air produced, 2,700 grams; time, 55·5 minutes; rate of production, 2,919 grams per hour; energy made available by liquid air, 284,602 calories, or 879,420 ft. pounds; average power supplied, 18,881 watts; total ft. pounds per hour supplied to motor, 50,129,055; efficiency of motor, 87·6 per cent.; power supplied to compressor in ft. pounds per hour, 43,913,052; efficiency of compressor and liquefier, 2·0 per cent.; efficiency of plant including motor, 1·7 per cent. The plant has been in frequent use for a year, occasionally running for three or four hours continuously, and the above results represent the performance under practical conditions. J. W. P.

227. *Effect of Low Temperature on Overstrained Iron and Steel.* **E. G. Coker.** (Phys. Rev. 15. pp. 107–118, Aug., 1902.)—If a steel bar be overstrained, it will completely recover in about a month if left to itself at ordinary temperatures, and a wrought-iron bar similarly treated will similarly recover in about a week, the recovery in both cases occurring in but a few minutes if the temperature be raised to 100° C. At temperatures, however, below 0° the author finds almost complete arrest of recovery from overstrain in the case of steel, and the same occurs with iron after the recovery has proceeded to a certain extent. The experiments were made on bars about 8 in. long, which after overstrain were kept in snow and were periodically submitted to a cycle of changes in order to test their condition. [See also Abstract No. 1811 (1902).] R. E. B.

228. *Steady Temperatures of a Thin Rod.* **J. W. Peck.** (Phil. Mag. 4. pp. 226–238, Aug., 1902.)—Fourier's simple solution $V\,exp.\left\{-x\sqrt{(ep/ks)}\right\}$, for the steady temperature along a homogeneous long thin rod laterally radiating into a medium of constant temperature 0 and with one end kept at constant temperature V, gives the lines of flow as parallel to the axis, which is obviously inconsistent with the hypothesis of lateral radiation. The above solution is of course only approximate, and the author estimates the real bending of the lines of flow, in the case of a rod of circular section with radius a, by calculating the second approximation to the rigorous solution of the problem in Bessel functions, viz., $v = \Sigma\,.\,A_sJ_0(\lambda_s r)exp(-\lambda_s x)$, where λ are the roots of the surface-condition $eJ_0(\lambda a) = k\lambda J_1(\lambda a)$, and the coefficients A are to be determined from the end-condition $V = \Sigma\,.\,A_sJ_0(\lambda_s r)$. The isothermal surfaces then appear, if e/k is small, to be paraboloids of revolution given by $r^2 + 4x/\lambda_1 = (4/\lambda_1^2)\log(V/v)$. The author points out that the validity of Fourier's approximation depends not merely on the value of a, but also on that of the magnitude

$L = k/e$, which he calls the *thermal length modulus*, so that, even if thin, a rod of a badly conducting substance may not conform to it. [The second approximations given in the paper are not good.] R. E. B.

229. *Maintenance of Low Temperatures.* **C. T. Knipp.** (Phys. Rev. 15. pp. 125–126, Aug., 1902.)—A coil of wire with its ends dipping into evaporating liquid air will keep the space within it at a steady temperature, which will be the higher the longer the ends and the finer the wire. The method is not economical, but may be very useful. R. E. B.

230. *Behaviour of Disthene and Sillimanite at High Temperatures.* **E. H. M. Beekman.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 295–298, Sept. 27, 1902.)—Three varieties of aluminium silicate [Al_2SiO_5] are found in nature, viz., disthene, andalusite, and sillimanite, the two latter being rhombical, the former triclinic. Now, according to Vernadsky's experiments, disthene, as well as andalusite, at a temperature of 1,350°, would pass into sillimanite, evolving heat by this conversion. This was inferred from the specific weights. The author proceeds to testing these results, the values found for the specific weights agreeing fairly well with those given by Vernadsky. The behaviour of the refractive index did not, however, tend to show a conversion into sillimanite, the indices of both sillimanite (1·68) and andalusite (1·64) remaining perfectly constant, and even for the highest temperatures obtained by means of an artificial blow-pipe. The refractive index of disthene, on the other hand, is found to decrease from its initial value 1·73, as the specimens are previously heated to high temperatures, the amount of decrease depending on the maximum temperature reached. Curves are given representing the index in terms of this maximum temperature, the lowest point of which corresponds with a value 1·62, the value 1·68 characteristic of sillimanite being crossed for a temperature 1,250°. It is inferred that this phenomenon may be due to a mixture of different bodies being present, one of which gradually assumes a prominent part. The author suggests applying this phenomenon to constructing maximum pyrometers, as after a given heating a definite value of the index is obtained. A. G.

231. *Continuous Electrical Calorimetry.* **H. L. Callendar.** (Roy. Soc., Phil. Trans. 199. pp. 55–148, Aug. 11, 1902.)—A history of the evolution and development of the method devised by the author for the measurement of the specific heat of water [see Abstract No. 1879 (1899)] is given at length, together with an exact account of the construction, testing, perfecting, and use of the electrical and calorimetrical apparatus finally employed in the investigation by Barnes, of the precautions that are necessary to be taken, and of the corrections that have to be applied to the readings made. Reasons are then given for adopting as thermal unit the calorie at 20° C. and for choosing a standard scale of temperature [see Abstract No. 85 (1900)], and the results of various experimenters are discussed, including those of Barnes, with the conclusion that the results given in the paper corresponding to the first-mentioned Abstract are the most probable. Finally, the variation of the specific heat is discussed theoretically, with special reference to a former paper. [See Abstract No. 374 (1901).] R. E. B.

232. *Specific Heat of Supercooled Water.* **H. T. Barnes** and **H. L. Cooke.** (Phys. Rev. 15. pp. 65–72, Aug., 1902.)—The specific heat of supercooled water was determined by a method of mixtures, the supercooled water being mixed with an equal weight of warm water, so that on mixing in the calorimeter the temperature of the latter was almost unchanged. The temperature of the cold water varied from — 3·3° to — 5·5°, measurements being also made with water at the freezing-point. The following table shows the variation in the specific heat of water between — 5° and 100° :—

VARIATION OF THE SPECIFIC HEAT OF WATER IN TERMS OF A THERMAL UNIT AT 16° C.

Temperature.	Spec. Heat.	Temperature.	Spec. Heat.
— 5° C.	1·0158	50° C.	0·99800
0	1·0094	55	0·99850
+ 5	1·00530	60	0·99910
10	1·00230	65	0·99970
15	1·00030	70	1·00035
20	0·99895	75	1·00100
25	0·99806	80	1·00166
30	0·99759	85	1·00237
35	0·99735	90	1·00305
40	0·99735	95	1·00370
45	0·99760		

T. M. L.

233. *Latent Heats of Vaporisation of Organic Compounds.* **W. Louguinine.** (Annal. Chim. Phys. 27. pp. 105–144, Sept., 1902.)—The author's measurements give the following mean results in addition to those already published [see Abstracts Nos. 815 (1901), and 2223 (1902)]. (1) Specific heats : Orthotoluidine, 0·5239 (between 21·68° and 195·99°) ; methylaniline, 0·5126 (between 20·05° and 196·50°) ; dimethylaniline, 0·4822 (between 20·60 and 188·33°) ; dimethyl-*o*-toluidine, 0·4949 (between 20·70° and 185°) ; dichloracetic acid, 0·3498 (between 21·22° and 196·12°) ; propionic acid, 0·5596 (between 20·07° and 137·42°) ; anisol, 0·4831 (between 19·90° and 151·76°) ; nitrobenzene, 0·3963 (between 20·5° and 199·5°). (2) Boiling-points at 760 mm. pressure and their variation for a change of 1 mm. pressure :—

	Boiling-point.	Pressure-coefficient.
Aniline	184·25°	0·053°
o-Toluidine	198·12	0·054
Methylaniline	194·36	0·052
Dimethylaniline	192·68	0·056
Dimethyl-*o*-toluidine	183·90	0·056
Dichloracetic acid	194·40	0·0495
Propionic acid	141·05	0·043
Methylethylacetoxime	181·89	0·044
Anisol	153·53	0·051
Butyronitrile	117·40	0·049
Nitrobenzene	210·60	0·059

(3) Latent heats of evaporation : Aniline, 104·32 ; *o*-toluidine, 95·085 ; methylaniline, 95·07 ; dimethylaniline, 80·97 ; dimethyl-*o*-toluidine, 70·25 ; dichloracetic acid, 79·10 ; propionic acid, 91·44 ; methylethylacetoxime, 115·69 ; anisol, 81·39 ; butyronitrile, 114·88 ; nitrobenzene, 79·15. The values for

Trouton's formula calculated from these numbers show that aniline and the four derivatives examined are not polymerised in the liquid state, but that the vapours of dichloracetic and propionic acids are polymerised to a considerable extent. Methylethylacetoxime, which contains a hydroxyl-group combined with nitrogen, is polymerised, but not to such a degree as the alcohols or acids, where the hydroxyl is united to carbon. The nitro-group differs from the hydroxyl-residue in not causing polymerisation of the compounds containing it. Anisol and butyronitrile are not polymerised in the liquid condition. T. H. P.

234. *Heat Evolved or Absorbed from Mixture of a Liquid and Finely Divided Solid.* **G. J. Parks.** (Phil. Mag. 4. pp. 240–253, Aug., 1902.)—The object was to find the relation between the quantity of heat evolved and the area of the surface of the solid exposed to the mixing, the rate of variation of heat evolved with variation of temperature, and to apply to the results the laws of thermodynamics. It is essential that the powder should be perfectly dry and should be at exactly the same temperature as the liquid. The powders used were of course insoluble in and unacted on chemically by the liquid. A description is given of the calorimeter and method. Precipitated silica, cylindrical filaments of silica, and sand are investigated. The following law is enunciated: When silica, sand, or glass is brought in contact with water at approximately constant temperature, the heat evolved is proportional to the area of surface exposed by the solid, and the amount of heat developed per sq. cm. is about 0·00105 calorie when the temperature is near 7° C. Application of the laws of thermodynamics is given. Experiments of a qualitative nature were made with mercury as the liquid. J. W. P.

235. *Critical Phenomena in Partially Miscible Systems.* **J. P. Kuenen.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 318–328, Sept. 27, 1902.)—The author continues his researches in the condensation phenomena of mixtures of two bodies which in the liquid state are not miscible in all proportions. Mixtures of hydrocarbons with alcohols are tested, beginning with ethane and the lowest terms of the alcohol series. For mixtures with ethyl-, propyl-, isopropyl-, and butyl-alcohol there are two limiting temperatures, between which three-phases—two liquids and vapour—are possible, the plait-point curve consisting of two branches starting from the critical points of ethane and the alcohol respectively. The terminal points of these two branches are found to approach one another for the higher terms, no two layers of liquid being observed any more in the case of amyl-alcohol, where the plait-point curve is an uninterrupted continuous line connecting normally the two critical points. Van der Waals' views as to a "theoretical" line connecting the two critical lines, as well as his criticisms on the author's views, are very fully discussed and the experimental results for the case of methyl-alcohol and ethane are recorded at length. The critical line, starting from the critical point of the alcohol, behaves first in a normal way, as the association does not exert any sufficient influence on the form of the surface, whereas, later on, this is notably altered. Methyl-alcohol and ethane will mix by pressure, thus forming a counterpart of phenol and water. These researches are to be continued with higher hydrocarbons. [See also Abstracts Nos. 898 and 2229 (1902).] A. G.

236. *Heat Capacity of Water and the Mechanical Equivalent.* **H. T. Barnes.** (Roy. Soc., Phil. Trans. 199. pp. 149–263, Aug. 13, 1902.)—This is a long and important paper describing experiments by the continuous-flow method of calorimetry. The calorimeter in its essential parts consists of a narrow tube through which water flows, becoming heated in its course by an electrically heated wire. The temperatures of ingress and egress are measured, the electric energy supplied to the wire is known, and the radiation losses (which take place in a vacuum jacket) are allowed for. Thus the value of the equivalent can be determined. Heat losses by conduction from the ends of the tube are also allowed for. The electrical measurements are taken on a potentiometer arrangement, and incidental to this a description of tests on a variety of forms of Clark cell is given. The resistance measurements are given at length and involve new matter. The temperature measurements were effected by platinum thermometers, and those of time by a chronograph in which 1 cm. corresponded to a second. Measurements were made with five different calorimeters, and tables of figures are shown giving comparison of these. The following empirical formula giving the specific heat in terms of a unit at 16° is given—

$$0{\cdot}99733 + 0{\cdot}0000035(37{\cdot}5 - t)^2 + 0{\cdot}00000010(37{\cdot}5 - t)^3$$

where t is the temperature. This holds between 5° and 37·5°; another similar formula is given for above this range. The value of the mechanical equivalent is found to range from 4·2215 to 4·1765 according to temperature. The mean value between 5° and 95° is 4·18876. The paper closes with a consideration of the relation of this work to that of other observers.

J. W. P

237. *Atomic and Molecular Heats of Fusion.* **P. W. Robertson.** (Chem. Soc., Journ. 81. and 82. pp. 1233–1243, Sept., 1902.)—The author discusses the various relations put forward between the latent heats of fusion of substances and their atomic or molecular weights, and gives numbers which show that for the elements with atomic weights over 40 which do not expand on freezing, the expression $Aw/T\sqrt[3]{V}$ (A being the atomic weight, w the latent heat of fusion, T the absolute melting-point, and V the atomic volume) gives numbers, the deviations of which from the mean are but slightly greater than those observed in the case of Dulong and Petit's law; some of these values are given in the following table:—

Element.	$Aw/T\sqrt[3]{V}$.	Element.	$Aw/T\sqrt[3]{V}$.
Zinc	1·28	Thallium	1·02
Cadmium	1·10	Iodine	1·29
Mercury	1·00	Copper	1·20
Palladium	1·08	Silver	1·10
Platinum	1·23	Bromine	1·63 (?)
Gold	1·11	Bismuth	1·75
Tin	1·2	Gallium	2·05
Lead	0·87		

For a number of binary inorganic compounds investigated, the mean percentage deviation of the values of $Mw/T\sqrt[3]{V}$ (M being the molecular weight) is only ± 5, whilst great regularity is noticed in the values of this expression for organic compounds of similar constitution. Thus, the numbers for *p*-chloraniline, *p*-dichlorbenzene, *p*-dibrombenzene, and *p*-bromophenol are respectively 2·93, 2·76, 2·70, and 2·55, while acetophenone and benzophenone give the values 2·52 and 2·51 respectively. In carrying out the above investigations a number of latent heat of fusion and specific gravity determinations have been made, the results of which are summarised in the following tables :—

	Melting-point.	Latent heat of fusion.
Thallium	(290)°	7·2
Lead	(330)	6·45
Tin	(230)	14·05
Phenanthrene	100	25
Phenylacetic acid	77	32
m-dinitrobenzene	90	29·0
Thiosinamine	77	33·4
Tribromphenol	93	13·4
Tribromaniline	122	14·4

The latent heats of the three metals are based on the values given for their melting-points.

	Spec. grav. at 20°/20°.	Mol. vol. of solid.
Diphenylamine	1·160	105·6
m-dinitrobenzene	1·521	111·1
Benzophenone	1·172	155·3
α-naphthylamine	1·171	122·1
Azoxybenzene	1·248	158·8
Thiosinamine	1·219	95·1
Urethane	1·11	80·2
Chloracetic acid	1·58	59·8
Acetoxime	0·97	75·3
Tribromphenol	2·55	121·9
Tribromaniline	2·35	136·2

T. H. P.

REFERENCES.

238. *Problem in Conduction of Heat.* **H. S. Carslaw.** (Phil. Mag. 4. pp. 162–165, July, 1902.)—The solution of the problem of the flow of heat in an infinite solid bounded on one side by a plane, to which the isothermal surfaces are initially parallel, and across which radiation takes place into a medium at constant temperature, is here obtained by a method, involving Cauchy's theorem of contour integration, which is chiefly of mathematical interest. R. E. B.

239. *Equilibrium of a Heavy Gas.* **A. Schmidt.** (Ann. d. Physik, 8. 4. pp. 924–926, July, 1902.)—The author criticises Exner's paper [see Abstract No. 1323 (1902)], pointing out the error already indicated in the Abstract. R. E. B.

240. *Second Law of Thermodynamics.* **A. Denizot.** (Ann. d. Physik, 8. 4. pp. 927–928, July, 1902.)—This is a reply to Voigt [see Abstract No. 2233 (1902)], but the author obviously does not understand the unjustifiableness of his assumptions [see Abstract No. 1333 (1902)]. R. E. B.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

241. *Magnetic Effect of Electric Displacement.* **J. B. Whitehead.** (Amer. Journ. Sci. 14. pp. 109–128, Aug., 1902.)—In this paper the author describes experiments made to observe the magnetic effect of electric displacement, the existence of which was asserted from theoretical considerations by Maxwell. The apparatus used was modified from time to time in the course of the investigation, but the final form was as here described. From each end of a light horizontal beam, suspended at its middle point by a quartz fibre, there hung a small cylinder of dielectric. Two concentric brass cylinders were placed with their axis in the vertical line of the quartz fibre, so that as the beam oscillated the dielectrics described arcs of circles with their centres in the common axis of the cylinders, and of radius intermediate between those of the cylinders. These cylinders were electrodes between which a high difference of potential was maintained. A third brass cylinder coaxial with the other two, but of larger radius, had a coil wound upon it, so as to give, when energised, a vertical magnetic field. The author observed the deflection produced by the magnetic field alone, by the horizontal electric field, and by both together, and especially observed whether the deflection changed in direction when the direction of one of these fields was suddenly altered while the other remained steady. Extensive experiments were made, but only on one occasion was such a reversal of deflection obtained. The author thinks this single result must be questioned, and says that the mass of evidence derived from his research is against the presence of the magnetic effect of electric displacement in an amount given by Maxwell's expression.

W. C. H.

242. *Permanent and Variable Electrostatic Field of a Helix Traversed by an Electric Current.* **M. Brillouin.** (Annal. Chim. Phys. 26. pp. 460–470, Aug., 1902.)—The author considers a circuit formed by a cylindrical shell of any section, one generator being the seat of the electromotive force, and every right section being in exactly the same state. He shows how to find mathematically the permanent and variable states, and treats fully the case of the (infinitely long) right circular cylinder. He also compares the magnetic with the electrostatic field. It is important to notice that the electrostatic field due to a current-carrying helix varies with any alteration in the winding, while the magnetic field depends only on the distribution of current densities.

W. S.

243. *Electrodynamic Theory of Hertz with Regard to Induction Phenomena.* **T. Levi-Civita.** (Accad. Lincei, Atti, 11. pp. 75–81, Aug. 3, 1902.)—The author refers to a former statement of his own [Influence of an electric screen. See Abstract No. 1370 (1902)] that Hertz' theory did not give two limiting conditions required for the complete mathematical determination of electrodynamic induction. This statement he now says was inaccurate, and in the present paper he proposes to show how the problem of induction receives unique solution by means of Hertz' theory. A conducting surface is treated as the limit of a conducting space between the two planes $z = h$ and $z = -h$ when h becomes infinitely small. Let X, Y, Z, L, M, N denote generally the components of electric and magnetic force respectively, so that the tangential components of electric force are for the conducting space in question, X_1, Y_1 at the lower, and X_2, Y_2 at the upper surface. Then Hertz's equations bring out the well-known result that these tangential forces are continuous in crossing the surface formed by reducing h to zero. On the other hand the tangential components of magnetic force undergo abrupt change in crossing that surface—

He then supposes a field in which (firstly) the electric and magnetic forces X', Y', Z', L', M', N' are subject everywhere to "regular" conditions, and (secondly) conducting surfaces are introduced into the field. This gives rise to forces of induction, with the result that X' becomes X, &c., or the components of the induced forces are $X - X' = X$, &c. Also X_1^T, &c., are used to denote the tangential components of X, &c. Hertz's general equations now are:—

$$A\frac{dL}{dt} = \frac{dZ}{dy} - \frac{dY}{dz}, \text{ \&c.} \ldots\ldots\ldots\ldots \text{I.}; \qquad A\frac{dX}{dt} = \frac{dM}{dz} - \frac{dN}{dy}, \text{ \&c.} \ldots\ldots\ldots\ldots \text{II.}$$

A having its usual meaning, and X, &c., have to satisfy these. They also have to satisfy the two surface conditions—(*a*) the continuity of X_1^T, Y_1^T, Z_1^T; (*b*) the tangential components of magnetic force undergo in crossing the surface the discontinuity, for the x component:—

$$\Delta_1 = \frac{4\pi}{AR}(\beta Z_1^T - \gamma Y_1^T) + \frac{4\pi}{AR}(\beta Z'^T - \gamma Y'^T)$$

with corresponding expressions for y and z. Here $\alpha\ \beta\ \gamma$ are the direction cosines of the normal to the surface.

The proposition is then established that there cannot exist two systems of integrals of the Hertz equations I. and II., which satisfy the "regular" conditions at all points not on the conducting surface, satisfy on that surface conditions (*a*) and (*b*), vanish at an infinite distance, and coincide at a given instant of time.

S. H. B.

244. *Experiment Relating to the Application of Lagrange's Equations to Electric Currents.* **W. S. Day.** (Phys. Rev. 15. pp. 154–162, Sept., 1902.)—Maxwell, in his "Electricity and Magnetism," vol. ii. section 574, describes an experiment to test whether the kinetic energy of a wire in motion with one degree of freedom denoted by x and carrying an electric current $\dot{y}$ contains any term of the form $K\dot{x}\dot{y}$. In Maxwell's experiment the velocity $\dot{x}$ of the wire was in the direction of its length, *i.e.*, the velocity of a circular wire round the axis perpendicular to the circuit. He found no indication of any such term. The present writer describes an experiment in which the wire carrying the current was straight, and the object was to ascertain whether the term $K\dot{x}\dot{y}$ could be proved to exist, $\dot{x}$ denoting angular velocity of the straight wire round its axis of figure. The details of the experiment cannot be satisfactorily described in an Abstract. In the result a maximum value was found for K, namely 0·00002 dyne cm. The form of the experiment was that of suddenly starting or stopping the current, and observing the torsion of the wire. The converse method might be employed, but in the opinion of the author did not give promise of greater sensitiveness, and was not tried.

S. H. B.

245. *Fundamental Equations of Electromagnetic Phenomena.* **H. A. Lorentz.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 305–318, Sept. 27, 1902.)—The electron theory is based on two kinds of equations, viz., first relations governing the alterations of state in the free ether, and in the second place formulæ for the forces the ether exerts on the electrons. By convenient hypotheses as to the electrons present in different bodies, and the forces which the ponderable matter exerts on these particles, this theory endeavours to account for the phenomena observed in dielectrics, conductors of current, and magnetisable substances. The author, in preceding researches, after showing that the laws of electrostatics and electrodynamics, as well as those governing induced electrical currents, may be derived from the fundamental formulæ, had applied the theory to the propagation of light in transparent bodies moving through the immovable ether with a constant speed [see Abstract No. 1680 (1902)]. He now shows how to develope, for bodies of any kind, moving in a given manner, equations, containing, in place of single electrons, only magnitudes comparable with the visible parts of bodies, and therefore capable of being determined by experiment. These equations correspond in form with known formulæ. A. G.

246. *A Problem of Electrostatics.* **E. Almansi.** (N. Cimento, 4. pp. 81–94, Aug., 1902.)—Duhem in his "Lecons sur l'Électricité et le Magnetisme" (livre iii. chap. i.) has treated the following problem: C and c are two conductors of which the dimensions of c are much smaller than those of C. Then C being charged with electricity, c is brought into contact with it, and acquires a charge e. If h be the density before the contact is made at that point of C which c is made to touch, it is found that e/h is constant and depends only on the geometrical form of c, and on the position on C of the point of contact. From which we can experimentally determine h by measuring e. The writer in this note gives a proof of the proposition more convincing (he says) than that given by Duhem. It consists in showing that if E be the mass of a distribution on C whose potential V is constant over C, and if $e = 4\pi h e_1$ be the mass of a distribution on c whose potential on c varies as the distance z from the common tangent plane of C and c, and has very small value on C, then the distribution of mass $\mathrm{E} - e$ on C, and of e on c gives approximately constant potential over the two conductors. Hence this is the distribution which will take place. And the ratio $\frac{e}{h} = 4\pi e_1$. The case is then considered in which e is bounded in part by the common tangent plane of C and c. In the general case c may have any form, but coincides in part with the common tangent plane. It is then found that the quantity of electricity e which passes from C to c is always greater than the quantity, $h\omega$, which before contact existed on that part of C, namely, ω, which is covered by c. In the special case of c being a hemisphere $e = 8h\omega$.

Finally the case is discussed in which c is a thin circular disc. S. H. B.

247. *Automatic Registration of Lightning.* **A. Turpain.** (Écl. Électr. 32. pp. 449–456, Sept. 27, 1902.)—An electro-radiograph has been mounted at Chateau-Pavie, 35 km. inland from Bordeaux, in connection with the appliances for hail-averting cannonades. The hill selected has a height of 75 m., and there is no higher point between this hill and the sea-coast, which, reckoning in a W.S.W. line, in which direction thunderstorms mostly approach, is 93 km. distant. To a mast 15 m. in height a yard has been fixed obliquely, and from the end of the yard the antenna wire is suspended, and most carefully insulated. The antenna forms a band of copper, 50 cm. in width, 28 m. long. It is joined to a coherer which is earthed below, earth being made by a lightning conductor ending in a well 80 m. distant. A branch circuit comprises one cell and a relay; the relay circuit a battery, the decohering electromagnet, and the registering and warning device. The latter circuit starts from a special polarised relay, and comprises a little mercury circuit-maker; each time the decoherer operates a drop of mercury falls into a vessel which finally tilts. Thus only a succession of lightning-flashes will call the observer from his house, 200 m. from the station. The coherer must not be too sensitive; the magnetic coherers of Tissot have answered best. It is proposed to use four coherers of different sensitiveness, and thus to obtain information as to the direction in which the storm moves. The registering mechanism is joined to a registering Richard barometer, so that barometer and lightning records appear on the same card. H. B.

DISCHARGE AND OSCILLATIONS.

248. *Sparking Distances between Plates.* **R. F. Earhart.** (Phys. Rev. 15. pp. 163–171, Sept., 1902.)—The paper is a continuation of an earlier one [see Abstract No. 514 (1901)], in which the potential was given by a battery of storage cells. In the present paper an alternating e.m.f. is used without apparent effect on the previous results. To measure the sparking distances, which vary from one wave-length of yellow light to several hundreds, an interferometer is used. Up to about three wave-lengths the potential varies proportionally to the distance, after which the rise is not so rapid. The effect of introducing a capacity seems to be to round off the elbow of the curve; below this point a less, while for greater distances a higher, e.m.f. is required with a capacity included. R. S. W.

249. *Sparking Distances in Air and Oils.* **E. Jona.** (Atti dell' Associazione Elettrotecnica Italiana, 6. pp. 3–32, June 3, 1902.)—The experiments described are in continuation of those made on sparking distances in air [see Abstract No. 1173 (1899)]. In the latter the highest pressure reached was 60,000 volts, but for the present experiments the author had at his disposal a 50-kw. transformer giving pressures varying from 6,000 to 165,000 volts. The terminals used were mostly a point and a disc, but for the sake of comparison some measures were taken of sparking distances between spheres. The pressures were measured directly by an electrostatic voltmeter of the author's construction. Very complete tables and curves are given of the results. The curves in general are concave towards the axis of distances, and show a bend, in many cases sharply defined, at a certain point. Experiments on the strength of oils at different temperatures show no weakening as the temperature rises, as might be expected from the large decrease of resistance with rise of temperature. Tests on a paper-insulated cable at temperatures between 0° and 100° C. show no appreciable variation in the strength. The author finally describes some comparisons made between low and very high-frequency currents, and describes with illustrations the transformer used. G. H. B.

250. *Influence of Ultra-violet Radiation on the Discharge in a Vacuum Tube having a Polished Zinc Electrode.* **W. C. Baker.** (Cambridge Phil. Soc., Proc. 11. pp. 472–476, Aug., 1902.)—The author describes the results of experiments made to measure the "negative drop" in a vacuum tube, having a kathode of polished zinc illuminated by ultra-violet light, in order to see whether the radiation produced any measurable change. The "negative drop" was found to be the same, whether the radiation was falling on the kathode or not. No change was detected in the magnitude of the current when the kathode was illuminated or when the light was shut off. If a change does occur, it is at least less than one-half per cent. The ultra-violet light produces a marked change in the potential required to start the discharge, lowering its value considerably. In experiment the reduction was from 558 volts to 510 volts. By gradually lowering the potential difference after the discharge had been started and then all rays cut off, it was found possible to carry the potential to a point at least 3 or 4 volts lower than the minimum potential required to start the discharge by the action of the ultra-violet light. The effect is due to the action of the radiation at the kathode and not, to any appreciable extent, to a volume ionisation by the rays as they pass down the path of the discharge. W. C. H.

251. *High-pressure Spark-gap with Tesla Coil.* **F. J. Jervis-Smith.** (Phil. Mag. 4. pp. 224–226, Aug., 1902.)—The discharge from the secondary of a Tesla coil is enormously increased by putting the spark-gap in the primary condenser circuit under an increased air pressure. When such a high-pressure spark-gap is placed in the secondary of an induction coil the effect of the coil when used as a generator of Hertz waves is greatly increased. A. D.

252. *Increase in the Electrical Conductivity of Air Produced by its Passage through Water.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 11. p. 505, Aug., 1902.)—Air from a large gas-holder of about 350 litres capacity was bubbled vigorously through water by making the air in the vessel circulate through a water-pump. An increase in the conductivity of the air to ten or twelve times the original value was observed. The air remains in this highly conducting state for some time. The effect produced is similar to that which would be caused by the production of a radio-active emanation like that from thorium and radium. Passage through a red-hot tube destroys the conductivity of the air, but the temperature must be above 300° or 400°. Slow passage over beads moistened with sulphuric acid in a long tube destroys the conductivity, but unless the passage is very slow a large part of the conductivity is still retained under these circumstances. A conductor strongly electrified negatively when kept in the gas some time becomes itself radioactive. J. J. S.

253. *Flames in an Alternating Electrostatic Field.* **G. C. de Rossi** and **A. Sella.** (N. Cimento, 4. pp. 94–130, Aug., 1902.)—The authors, after referring to the work of MacClelland and Zeleny [see Abstracts Nos. 100 and 251 (1899)] describe the results of work with various flames within the field, the products of combustion being carried out of the field. Flames range themselves in three classes: those which give no current (CS_2, H, H_2S, CO); those which give a positive current from flame to earth (C_2H_6, $(C_5H_{11})C_2H_3O_2$, $C_2H_6O_2$, coal gas, coal gas and air, C_2H_2, CH_4, Na Cl and Rb Cl beads in H, CN, camphor, stearine, paraffin (S ?); and those which give a negative current (P, S ?). For most flames the negative ions leave the flame more rapidly than the positive do: the reverse of what happens in the electric arc. In cases where there is no current, either the ions fail to persist or the velocities are equal; the latter appears to be the explanation. In the flames giving positive currents the current increased the more nearly the two plates of the condenser approached the flame; but in some, not in others, the distance from one plate at which the current was a maximum did not depend much upon the distance between the plates. This is discussed theoretically. Deformations of flames in an alternating field are then considered, and their relation generally to the production or otherwise of a current. In a rotating field the current rose towards a limit with increase of voltage: the positive ion did not even reach the armature. There was no rotation of the flame. A. D

ELECTRICAL PROPERTIES AND INSTRUMENTS.

254. *Measurement of Electrolytic Resistances.* **C. Hering.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 827–833, June–July, 1902.)—The author describes a method of measuring the resistance of a length of electrolyte in a bath by means of ordinary direct-current instruments. He constructs a liquid potentiometer by sending a known current through the bath between electrodes at its ends, and connecting two intermediate auxiliary electrodes in series with a galvanometer and a cell of known e.m.f. The distance between the electrodes is varied until the galvanometer shows no current in the auxiliary circuit. The drop of potential between the auxiliary electrode is then known, and is independent of any polarisation. The material of these electrodes is of importance. It must not combine with the electrolyte, nor with the products of decomposition formed by the current passing before zero-point is reached. The author found gold to be by far the best material in electrolytes where oxygen or hydrogen were evolved, and preferable to platinum. The author points out that theory would indicate that the method is inapplicable, since it would appear that there could be no inverse current in the auxiliary electrodes until the fall of potential between them is great enough not only to overcome the e.m.f. of the battery, but also that for the decomposition of the electrolyte. He can attribute the success of the method in practice only to condenser action of the auxiliary battery. G. H. B.

255. *Automatic Regulation of the Potential of a Condenser.* **V. Crémieu.** (Journ. de Physique, 1. pp. 583–588, Sept., 1902.)—The author describes a method of securing automatic regulation of the potential of a condenser. An absolute electrometer is made to serve as regulator, and the special device of the author, by which he has obtained highly satisfactory results, involves the use of his type of electrometer and electrostatic relay, already described. [See also Abstract No. 1545 (1902).] W. C. H.

256. *Apparatus for Rapidly Calibrating Voltmeters.* **F. A. Laws** and **W. D. Coolidge.** (Technology Quarterly, 15. pp. 69–73, March, 1902.)—This apparatus was designed for rapidly testing the thirty or forty portable direct-current voltmeters which are in continual use in the Massachusetts Institute of Technology. It consists of two small dynamos directly coupled together, and belt-driven by an electric motor. The armatures are wound to give 1,500 volts at 1,600 r.p.m., and the current capacity is a quarter of an ampere. They can be connected in series, and so any voltage from zero to 3,000 can be obtained. In order to minimise fluctuations of the pressure the commutators have 150 segments. The switches are so adjusted that the operator has to begin at zero and build up the pressure so that there is little risk of damaging an instrument by applying too high a voltage. Special precautions are taken against shock. By using a heavy flywheel and working the dynamo fields near saturation a Weston voltmeter can be compared easily with the standard to an accuracy of 0·1 per cent. A. R.

257. *Induction Coils.* (Elect. Rev. 51. pp. 390–391, Sept. 5, 1902.)—Account of Kinraide's coil, designed to get over the difficulty as to the insulation between the ends of the secondary and the ends of the primary coil. The primary and secondary coils are divided into two halves, and the primary coil is placed outside the secondary. There is a rotary brake, and each interruption charges and discharges a condenser. No iron core.

A. D.

ALTERNATING CURRENTS AND MAGNETISM.

258. *Dissipation of Energy by Induced Currents in Rotating Iron Cylinder.* **E. Wilson.** (Roy. Soc., Proc. 70. pp. 359–374, Aug. 9, 1902.)—A previous paper explains the apparatus and methods used [see Abstract No. 1376 (1902)]. It is the object of the present paper to investigate experimentally and theoretically the energy dissipated by the currents generated in an iron cylinder when rotated in a magnetic field. Coils are inserted in various places in the cylinder by drilling out holes; the e.m.f. acting in each coil is found by observation on a d'Arsonval galvanometer placed in circuit with each coil. Curves are given showing how e.m.f. in each coil varies as the cylinder rotates. From these curves deduce the effective e.m.f. acting in the assumed path of the induced current. The rate of dissipation of energy is taken to be the square of this effective e.m.f. divided by the resistance of the assumed path. By integration the total watts dissipated in a given plane parallel to the axis is found. By integration with respect to the horizontal axis obtain the energy dissipated in the half cylinder. In this calculation everything depends on the path assumed for the currents. Of the various possible paths, there is one outstanding which gives results agreeing closely with theory, viz., a path which is a cylinder similar to and concentric with the cylinder experimented on. **J. B. Dale,** in an appendix to the paper, gives a mathematical investigation of this and various other possible cases.

P. E. S.

259. *Demagnetising Effects of Alternating Currents.* **Z. E. Crook.** (Amer. Journ. Sci. 14. pp. 133–146, Aug., 1902.)—An alternating current is sent through a magnetised iron wire; does it affect the magnetisation of the wire independently of the action of the circular magnetism? To solve this problem a block of iron was built up of thin laminæ insulated from one another so that the current sent in at one end of the block traversed adjacent laminæ in different directions and left at the other end of the block. The block was placed in a special yoke [see Abstract No. 1533 (1901)] for the bar-and-yoke method. The frequency of the alternations was 133 per second. It is found that residual magnetism is removed by continuous currents, but much more so by alternating currents. In a second method two thin sheets of iron were insulated and rolled into a compact tube. A magnetising coil was placed outside this tube and a test coil was allowed to drop from any given place on the tube, to determine the magnetic flux. The results were much as before. P. E. S.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

260. *Loss of Weight on Chemical and Physical Change.* **A. Heydweiller.** (Phys. Zeitschr. 3. pp. 425–426, July 1, 1902.)—This is a reply to Lord Rayleigh's remarks in "Nature," June 20, 1901, and Abstract No. 2269 (1902), on the author's results [see Abstract No. 1760 (1901)]. That the loss of weight alleged is inconsistent with the reversibility of a solution cycle is not conclusive, for the reversibility is itself impossible on account of secondary actions at present obscure. For example, the addition of an acid which appears to have nothing to do with the reaction is found to increase the apparent loss of weight considerably. Landolt has found (Naturw. Rundschau, 17. 218, 1902) a loss of weight upon solution of NH_4Cl in water and upon reaction between HI and HIO_3. There is no case in which an increase of weight has been established. A. D.

261. *Ratios of the Atomic Weights.* **A. Marshall.** (Chem. News, 86. pp. 88–89, Aug. 22, 1902. From the Chemiker Zeitung, July 19, 1902.)—The author calculates that when the atomic weights are referred to $O=16$ their tendency to approach whole numbers is about thirty times as great as when they are referred to $H=1$. He points out some remarkable regularities that appear when they are referred to entirely different standards. Thus taking the atomic weights of the German Committee, when the numbers for Cl, Br, Ag, and I are multiplied by 2·53868, we get the whole numbers 90, 203, 274, 322. In the case of Li, NH_4, Na, K, Rb, division by 1·004 gives 7, 18, 23, 39, 85 *exactly*, excepting a small difference in the case of sodium. The same factor gives practically whole numbers with Pb, Cd, V, Pt, Sn, Ca, Al. The horizontal series from V to Zn inclusive, in the periodic table, give, when multiplied by 1·0551, whole numbers with the exception of copper, which is very near, and cobalt. The author considers that there is a connection between these regularities and the *phenomena of* isomorphism. S. R.

262. *Calculation of Atomic Weights.* **F. W. Clarke.** (Chem. News, 86. pp. 77–79, Aug. 15, 1902. From the American Chem. Journal, xxvi., No. 5.) —In the ordinary discussion of ratios relative to atomic weights, different results may be obtained by varying the method of computation, owing to the fact that the ratios as measured are not absolute, but subject to errors, which should be, but are not usually, distributed. In most cases the tendency is to accumulate all errors, accidental or systematic, upon the constant which is last determined. This paper contains recalculations of nine important elements, based on the rule of giving each measurement weight inversely proportional to the square of its probable error. The need is shown of determining forty or fifty new ratios, which by co-operation between several workers might be accomplished within reasonable time. [See Abstracts Nos. 1509 (1900), 1561 (1901), and 186 (1903).] S. R.

263. *Molecular Weight Determination.* **E. B. Ludlam.** (Chem. Soc. Journ. 81. and 82. pp. 1193–1202, Aug., 1902.)—A simple and inexpensive form of Landsberger's boiling-point apparatus is figured and described. It has enabled the molecular weights of a number of bodies to be ascertained with

considerable rapidity and fair accuracy, the solvents used being benzene, CS_2, alcohol, and pyridine. Incidentally it was observed that when mercurous chloride was boiled in pyridine it rapidly and completely dissociated, although the temperature was only 115°, into mercury and mercuric chloride, the latter combining with the solvent to a compound which crystallised out in hard, fine needles. S. R.

264. *Atomic Weight of Radium.* **Mme. Curie.** (Comptes Rendus, 135. pp. 161–163, July 21, 1902.)—By fractional crystallisation of a large quantity of radiferous barium chloride a decigramme of chloride of radium was obtained, of such purity as to show in the spectroscope only faint lines of barium. Three determinations of the chloride of silver obtained by precipitation with silver nitrate gave a mean atomic weight of 225, which is considered correct within one unit. When certain quantities of barium and radium are present, the crystals have a yellow or rose colour. Radium chloride itself is colourless and spontaneously luminous. The element by its chemical properties belongs to the alkaline-earth series, and in the periodic system takes its place between barium and thorium and uranium. S. R.

265. *Composition of Brittle Platinum.* **W. N. Hartley.** (Phil. Mag. 4. pp. 84–89, July, 1902.)—The platinum was spectrographically examined, and by careful comparison of the photographs no metallic impurity was found to be present, iron being especially tested for. Silicon and carbon were found to be absent, and phosphorus was the only one possible impurity. This could not be detected spectroscopically, but as phosphorus is known to occur in platinum, and as the sample in question was much improved by fusion, it was concluded that phosphorus was present. E. C. C. B.

266. *New Organic Constituent in Air.* **H. Henriet.** (Comptes Rendus, 135. pp. 101–103, July 15, 1902.)—The author, in conjunction with A. Lévy, has previously shown that when air is allowed to stand for a long time in contact with an alkali, there is a larger absorption of carbon dioxide than when the air is merely passed over the potash, soda, &c., so that there appears to be a secondary constituent in air which gradually produces CO_2 by decomposition. The author has now obtained solutions of this secondary constituent by adding moisture to the air (freed from carbon dioxide) and then condensing the moisture. Chemical examination of the condensed liquid shows the probable presence of a formanide, HCO.NHR. D. H. J.

267. *Report on the Discovery of a New Organic Constituent in Air.* **A. Carnot**, with **A. Gautier** and **Haller.** (Comptes Rendus, 135. pp. 89–92, July 15, 1902.)—In view of the remarkable discovery by Henriet and A. Lévy of a new organic constituent in air [see preceding Abstract], the Academy appointed a Commission to control the experiments and to initiate such fresh experiments as might be advisable. This Commission in its report confirms the results communicated by Henriet and Lévy; in one experiment an amount of extra carbonic acid was eliminated, corresponding to 21·6 litres in 100,000 litres of air. D. H. J.

268. *Heat of Hydration of Oxide of Zinc.* **de Forcrand.** (Comptes Rendus, 135. pp. 36–39, July 7, 1902.)—The author has endeavoured to redetermine the value of the heat of hydration of oxide of zinc. He prepared crystalline zinc hydrate corresponding to the formula $Zn(OH)_2$ by the

method given by Runge and studied by Nicklés. The heats of solution in dilute sulphuric acid of this hydrate and of the oxide prepared from it by heating at 125° were ascertained, and the heat of hydration thence found to be 2·19 calories starting from liquid water, or 0·76 calories from solid water. This result is regarded by the author as of precise interest. Experiments in which zinc oxide or hydrate are heated are complicated by phenomena of condensation. The condensed anhydrous oxide prepared at a red heat absorbs water to form a number of hydrates of varying condensation : the value for the fixation of one molecule of water is about 4·5 to 5 calories. Similar results are obtained by examination of the precipitated hydrate. The condensation of $nZn(OH)_2$ to $(ZnO_1H_2O)_n$ gives $n \times 3{\cdot}8$ cal. [See also Abstract No. 128 (1903).] D. H. J.

269. *Mixture Crystals of Sulphur and Selenium.* **W. E. Ringer.** (Zeitschr. Anorg. Chem. 32. 2. pp. 183–219, Sept. 15, 1902.)—Molten selenium and liquid sulphur mix in all proportions. The molten mass, however, provided the atomic percentage of selenium exceed 10, does not crystallise readily. Even with fairly slow cooling the mixture will solidify in the amorphous state, those containing large amounts of selenium requiring several hours' heating to a temperature near the melting-point, in order to become of a completely crystalline structure. Evidence is given from the melting-curves that these crystalline mixtures are made up of mixture crystals, no instance of a chemical compound being stated. Three series of mixture crystals have been found, according to the amount of selenium contained, out of which two are monoclinic, whereas those having from 87 to 100 atomic percentage of selenium belong to the hexagonal-rhomboidic system. The crystals of the first series are found to undergo, below certain temperatures, transformations into a rhombical modification analogous to those exhibited by monoclinic sulphur, those temperatures ranging from 95·5° to 75°. No such transformation is shown by the two remaining series. The following types are found to exist at ordinary temperatures : (*a*) one series of rhombical mixture crystals with 0 to ±10 atomic per cent. of selenium ; (*b*) one series of mixture crystals with 55 to 75 atomic per cent. of selenium ; (*c*) one series of the hexagonal type with 90 to 100 atomic per cent. of selenium. A. G.

270. *Relation of the Colour Changes of Cobalt and other Chlorides to the Theory of Electro-affinity.* **F. G. Donnan** and **H. Bassett, Jr.** (Chem. Soc., Journ. 81. and 82. pp. 939–956, Aug., 1902.)—The authors discuss the various theories brought forward to explain the changes of colour produced in solutions of cobalt chloride when the temperature, concentration, solvent, &c., are changed. A description is then given of electrolytic experiments and freezing- and boiling-point determinations carried out by themselves, and from their results the following conclusions are drawn : It is highly probable that the blue colour of solutions of cobalt chloride is largely due to the existence of complexes, such as $CoCl_4$ or $CoCl_3$, and that the colour due to the undissociated molecule, $CoCl_2$ in solution is not blue. On the other hand, the colour due to the cobalt atom when outside the immediate sphere of the chlorine atoms is apparently red. Thus the colour produced by free cobalt kations in aqueous solution is red, whilst the red colour of the solid hexahydrated cobalt chloride is doubtless due to the intervention of the water molecules between the cobalt and chlorine atoms. The colours exhibited by the cobalt double chlorides admit of a similar explanation. Thus, owing to the greater tendency of zinc to enter into negative complex groups, the zinc double chloride will have the constitution, Co — ($ZnCl_4$), whilst the calcium compound will be represented by (Ca — ($CoCl_4$), since cobalt has a greater tendency to form negative complexes than calcium; in agreement with this view, the zinc salt is red and the calcium blue. The blue colour of the lithium compound, $CoCl_2$, LiCl, $3H_2O$, may be similarly explained. The above indicates that it is possible that solid anhydrous cobalt chloride does not possess the simple formula $CoCl_2$, but that it may correspond to some polymeric complex form such as Co — ($CoCl_4$), its pale blue colour being determined by the strong absorption in the red produced by the complex group, $CoCl_4$. The change to reddish violet occurring at the temperature of boiling liquid air may be due to the breaking up of the complex grouping, which the authors show would be an exothermic change. The above considerations are applied also to the cases of cupric and ferric chlorides. T. H. P.

271. *Hydrates of Superchloric Acid.* **H. I. van Wyk.** (Zeitschr. Anorg. Chem. 32. 1. pp. 115–121, Aug. 28, 1902.)—The author determines the melting-curve of all $HClO_4$ and H_2O mixtures. This curve is found to be composed of the melting-curves corresponding to five hydrates, ice and solid $HClO_4$ respectively, the latter alone being incapable of being determined. The melting-curve corresponding to the hydrate $HClO_4\ H_2O$ (melting-point 50°) turns out to be the most extensive. The following new hydrates have been detected by the author: $HClO_4(H_2O)_2$, $HClO_4(H_2O)_3$, $HClO_4(H_2O)_4$, and $HClO_4(H_2O)_6$, with melting-points —20·6°, —47°, —40°, —45° respectively. In addition, there exists a metastable hydrate, with the melting-point —64°.

A. G.

272. *Colloidal Tellurium.* **A. Gutbier.** (Zeitschr. Anorg. Chem. 32. 1. pp. 51–55, Aug. 28, 1902.)—The author, some time ago, described a method for obtaining in a chemical way a most stable, liquid hydrosolution of gold [see Abstract No. 2105 (1902)], wholly analogous to the one proposed by Bredig by electrical pulverisation, and differing from all the remaining hydrosolutions of gold, as chemically prepared, by its blue colour. He has now succeeded in obtaining a similar colloidal modification of tellurium, both in the liquid and solid states, and in a most stable form. These hydrosolutions of tellurium are distinguished from electrolytes by their great stability.

A. G.

273. *Solvent Properties of Mixed Liquids.* **H. M. Dawson.** (Chem. Soc., Journ. 81. and 82. pp. 1086–1097, Aug., 1902.)—The ratio of distribution was determined of iodine between water and a binary mixture of organic liquids. As the concentration of the iodine in pure water is small, a decinormal solution of potassium iodide was used instead, and the concentration of the free iodine molecules in the aqueous layer was calculated by means of a formula; the necessary constants were determined by means of preliminary experiments, and the formula used was based on the equation $KI + I_2 \rightleftharpoons KI_3$, an equation which was tested in the case of carbon disulphide and aqueous solutions containing varying amounts of potassium iodide. Curves are given showing how the ratio of distribution varies with the percentage composition (by volume) of the binary organic mixture. In case of carbon disulphide mixed with benzene or toluene, the distribution-coefficients, which afford a

measure of the solvent power, are greater than those calculated from a simple mixture law, in the case of benzene and toluene the observed and calculated values are practically identical, whilst in the case of mixtures of chloroform with carbon disulphide or benzene and of light petroleum with benzene the observed values are less than those obtained by calculation. Maxima and minima, such as are found in the case of gases dissolved in mixtures of alcohol and water, were not observed. T. M. L.

274. *Double Salts in Solution.* **P. N. Evans.** (Chem. News, 86. pp. 4–5, July 4, 1902.)—Lead chloride is precipitated from a saturated solution by hydrochloric acid or sodium or potassium chloride, but not by lead nitrate; similarly barium chloride is precipitated by chlorides, but not by barium nitrate. In explanation of this abnormal behaviour it is urged that double salts are formed, such as $PbClNO_3$ and $BaClNO_3$. These could only crystallise if less soluble than either of the constituent salts, but may well exist in solution. T. M. L.

275. *Decomposition of Oxalacetic Hydrazone and the Concentration of Hydrogen Ions in Solution.* **H. O. Jones** and **O. W. Richardson.** (Chem. Soc., Journ. 81. and 82. pp. 1140–1158, Aug., 1902.)—Fenton and Jones showed [see Abstract No. 1153 (1901)] that oxalacetic acid phenyl hydrazone decomposes in presence of water at 100° into carbon dioxide and pyruvic hydrazone; in the presence of strong acids pyrazolone carboxylic acid and water are the products; with dilute acids both reactions occur, and the amounts of carbon dioxide given off, with acids of the same normality, are in the inverse ratio of the affinity constants. It was thought at first that the pyruvic acid hydrazone was formed by the decomposition of the negative ion, whereas the pyrazolone carboxylic was obtained by the decomposition of the original undissociated molecule. Experiment has shown that the results are better explained by supposing that the formation of pyruvic acid phenyl hydrazone is a unimolecular decomposition of oxalacetic acid phenyl hydrazone, and is proportional to the concentration of the latter at any given time. On the other hand, the production of pyrazone carboxylic acid is a bimolecular reaction, and the rate of formation is jointly proportional to the concentration of the hydrogen ions and to that of the oxalacetic acid phenyl hydrazone present in the solution. The reaction was investigated experimentally in two ways, viz., by observation of the total amount of carbon dioxide given off at 100°, and by determination of the rate of evolution of carbon dioxide at a constant temperature (about 80°). According to both theories, the amount of carbon dioxide produced satisfies the following equation: $\log 1/(1 - C_2/C_2^{\infty}) = \beta t$, where C_2 is the concentration of pyruvic hydrazone (or amount of carbon dioxide evolved) at any time t, C_2^{∞} the final concentration ($t = \infty$ theoretically), and β is a constant. The hypothesis of the decomposition of the negative ion requires that β should decrease with increasing concentration of hydrogen ions, whereas the view now put forward requires that β should increase, as was found experimentally to be the case. The authors point out that the decomposition of oxalacetic acid phenyl hydrazone furnishes an easy method of measuring the concentration of hydrogen ions. To determine this concentration in a given acid solution, 1 gram of oxalacetic hydrazone is heated with 100 cc. of the solution to 100° C. and the amount of evolved CO_2 (say "b" cc.) is ascertained. The concentration of the hydrogen ions in the solution is given by $x = (10/b - 1)/50$. D. H. J.